Enhancing the Dynamic Properties of a HNBR Elastomer Using Nano-Fillers

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Introduction

The aim of this project was to enhance the dynamic properties of a HNBR 90A compound by substituting a portion of the current filler system with Haydale's HDPlas™ functionalised multi-wall carbon nanotubes (MWCNT). Material hardness was maintained, by varying the loading of MWCNT, and properties tested.

Physical Properties

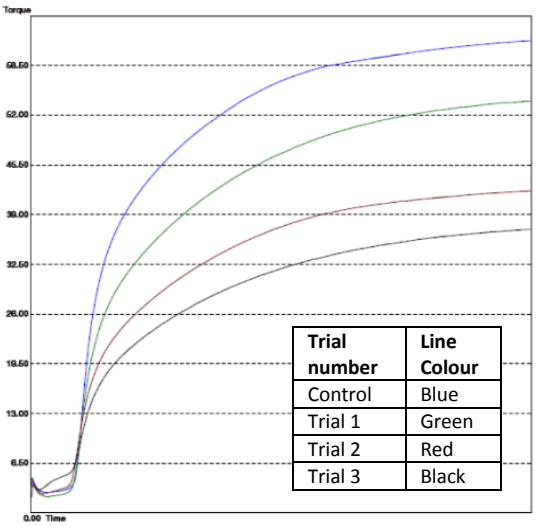
As existing filler was substituted the low extension modulus and elongation at break increased. Tear strength also increased with substitution. Density, as indicated by specific gravity, reduced with substitution.

Tensile Stress-Strain Properties					
Trial	**TS, MPa**	**Mod @ 50, MPa**	**Mod @ 100, MPa**	**Mod @ 200, MPa**	**E@B, %**
Control	18.9	6.0	8.8	15.3	277
Trial 1	19.4	5.9	8.9	15.0	295
Trial 2	19.9	6.6	10.1	15.9	310
Trial 3	20.2	8.2	12.6	16.7	340

Other Physical Properties				
Trial	**Hardness, Shore A**	**SG, g/cm³**	**Comp Set - 24h @ 150°C, %**	**Tear Strength, N/mm**
Control	92	1.18	38	57
Trial 1	92	1.16	40	61
Trial 2	92	1.15	39	64
Trial 3	92	1.13	41	76

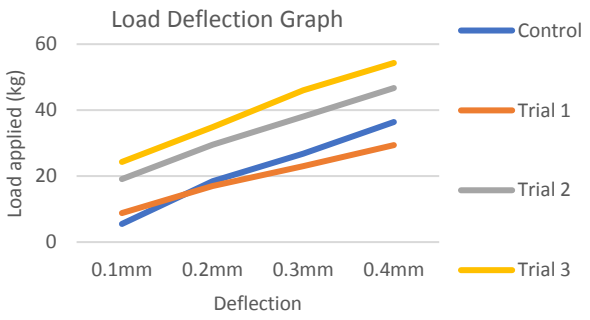
Curing Characteristics

Trial 3 displayed a thixotropic flow mechanism, whereas the other trials displayed equivalent dilatant behaviour. Maximum torque reduced dramatically through the trials.



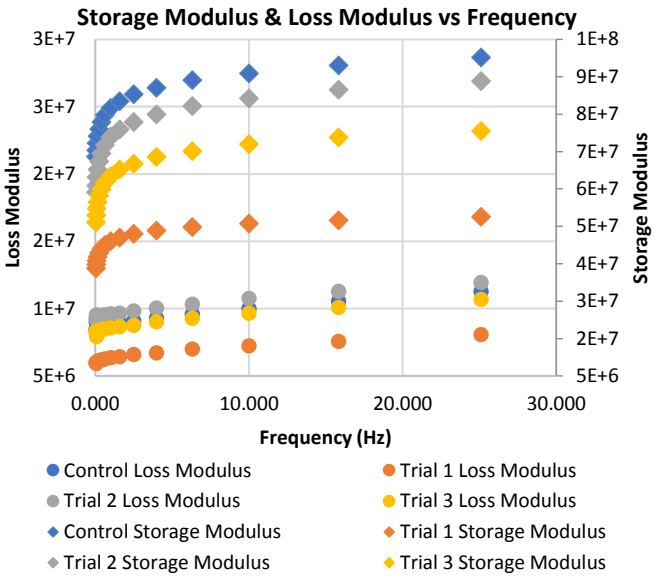
Load Deflection Characteristics

Trials using a higher MWCNT loading require higher forces for equivalent displacement in tension or compression.

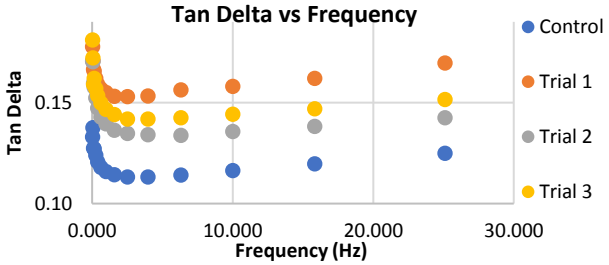


Dynamic Properties

The relative difference in storage modulus, G', and loss modulus, G", for these highly elastic materials means that small losses in the elastic response have a marked effect on tan delta.



Trial 1 had the highest tan delta at all tested frequencies. This is despite having the lowest loss modulus of all the trials. The higher tan delta figure for Trial 1 is due to the loss in G'.



Conclusions

Through substitution of an existing filler system with MWCNT we can tailor the dynamic characteristics of rubber compounds. Trials using MWCNT have lower densities, show higher tensile stress-strain, tear and load deflection characteristics and retain resistance to compression set.

Compounds containing MWCNT display anisotropic response when extending beyond the reinforcing domain of the high aspect ratio filler. Compounds with higher MWCNT loadings show more of a yielding type behaviour, as the reinforced regions from the high aspect ratio filler are exceeded. Therefore, there is an optimum loading of the nano-filler, after which properties begin to diminish.

Features & Benefits

- There may be the possibility to reduce certain geometries, by utilising the improved tension and compression characteristics.
- It may be possible to successfully mould more complex parts, due to the improved pliability at high temperature, and the higher tear resistance.
- Compounds using an optimised loading of HDPlas™ MWCNT display improved damping performance.